(19) Europäisches Pat ntamt
European Pat nt Office
Office europé n des brevets

(11) Publication number: **0 189 948 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 86200024.7

(22) Date of filing: 09.01.86

(51) Int. Cl.⁴: G 11 B 7/013
G 11 B 7/24, G 11 B 7/26
G 11 B 7/12, G 11 B 7/095
G 11 B 23/00

(30) Priority: 22.01.85 NL 8500153

(43) Date of publication of application:
06.08.86 Bulletin 86/32

(84) Designated Contracting States:
BE DE FR GB IT NL SE

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(54) **Record-carrier body provided with a relief structure of optically detectable servo-track portions and sector addresses and apparatus for forming said structure.**

(57) A record carrier body is described, provided with sector addresses (12) and servo-track portions (13). As the maximum width of the servo-track portions is at least 60% of the track period (P_r), in a direction transverse to the track direction, and is at least of the order of twice the maximum width of the sector-address areas (15), it is possible to obtain an improved tracking signal in addition to a satisfactory address signal. An improved information signal can be obtained by recording the information (22) in the lands between the servo tracks.

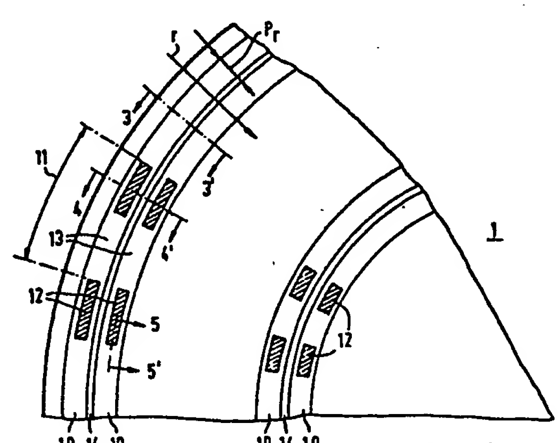

FIG. 1

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R ord-carrier body provided with a r liqf structure of ptically det ctable s rvo-track p rtions and s t r addresses and apparatus for forming said structure.

The invention relates to a record-carrier body in which a user can record information by means of optical radiation, which record-carrier body comprises a substrate and a recording layer on said substrate and which has been provided with a preformed optically detectable relief structure of servo-track portions and sector addresses in which address information about associated recordable portions of the record-carrier body is contained in the form of optically detectable areas which alternate with intermediate areas, which areas in the sector addresses have another phase depth than the servo-track portions. The invention also relates to an apparatus for recording a structure in conformity with the relief structure of sector addresses and servo-track portions of said record-carrier body.

The record-carrier body may be a circular disc-shaped substrate carrying a recording layer in which optically detectable changes can be produced by a radiation beam of sufficiently high intensity. The servo-track portions may comprise grooves recessed in the substrate surface or ridges formed on the substrate surface, and the sector-address areas may comprise pits recessed in the substrate surface or hills formed on this surface. The sector addresses may situated between successive servo track portions, viewed in the track direction, so as to form one composite track. This track extends over the entire surface area of the recording layer and is preferably a spiral track, but alternatively it may comprise a multitude of concentric tracks.

Wh n th s ct r addr sses and serv track p rti ns ar xpos d t a radiati n b am which is focuss d to f rm a small radiati n spot, this b am is split int a z r - rd r

subb am, first- rder subb ams and high r-ord r subb ams. Her in, phase depth is t be und rst od t mean the phas difference between the zero-order subbeam and a first-order subbeam. This phase depth is determined by the geometry of the sector-address areas and the servo-track portions, inter alia by the depth or height of these areas and track portions.

Such a record-carrier body is known inter alia from United States Patent Specification No. 4,363,116. As described in said Patent Specification, the servo-track portions are employed during the recording of information by the user for detecting and correcting the radial position of a radiation spot formed on the recording layer by a radiation beam. This enables the requirements imposed on the drive and guide mechanisms, for moving the write spot and the record carrier body relative to each other, to be less stringent, so that the write apparatus can be simpler and cheaper.

Preferably, the radial position of the radiation spot relative to a servo-track portion is detected by means of the "push-pull" or differential method. This method employs two radiation-sensitive detectors, which are arranged in the path of the radiation beam issuing from the record carrier body and which receive radially different portions of this beam. The difference between the output signals of the two detectors contains information about the radial position of the radiation spot relative to the servo-track portion. If said output signals are equal, the centre of the radiation spot coincides with the central axis of the servo-track portion. The differential tracking method may be employed only if the servo grooves have such a depth or the servo ridges have such a height that their phase depth is of the order of 90^{o}.

The sector-address areas are read using the "Central-Aperture" or integral method. In accordance with this m thod th variation f th v rall int nsity of the radiation originating from the r c rd carri r body

and traversing an objective system is detected by means of a single detector arranged on the optical axis or by means of the two detectors employed for tracking, whose output signals are added to each other. For optimum read-out of the sector addresses the areas therein should have a phase depth of approximately 180°.

It has been found that, in addition to the phase depth, the width, measured in the direction transverse to the track direction, of the servo- track portions and the sector-address areas also has a substantial influence on the amplitude of the signals obtained when the user information is recorded. In the record-carrier body in accordance with United States Patent Specification no. 4,363,116, which is intended to be scanned by means of a radiation spot whose half-intensity value is approximately 800 nm, the servo-track portions and the sector-address areas have a width of approximately 600 nm, whilst the period, transverse to the track direction, of the track structure is approximately 1600 nm. The half-intensity diameter of a radiation spit is equal to the distance between two points where the intensity is half the intensity in the centre of the radiation spot. By means of the known record-carrier body it is possible to obtain a different tracking signal of moderate signal amplitude.

It is an object of the invention to provide a record-carrier body which, when scanned for the purpose of information recording, produces a differential tracking signal of substantially higher signal amplitude. It is another object of the invention to obtain an improved information signal of higher signal amplitude when the information areas recorded by the user are read in accordance with the integral read method.

In accordance with a first aspect of the invention the record-carrier body is characterized in that the maximum width of the servo-track portions is at least 60 % of the track period, transverse to the track direction,

and is at least of the order of twice the maximum width of the sector-address areas.

The use of the concept "maximum width" is related to the fact that the servo grooves or ridges and the sector-address pits or hills need not have perpendicular walls, but in practice generally have oblique walls. The maximum width is then the width at the location of the recording-layer surface which is remote from the substrate. Apart from a maximum width the servo grooves and sector-address pits also have an effective width. The shallow servo grooves are generally V-shaped in cross-section. For such a groove shape the geometrical effective width is approximately half the maximum width. The deeper pits in the sector addresses are frequently trapezoidal. For such pits the effective width is equal to half the sum of the maximum width and the minimum width.

The invention is based on the recognition of the fact that for a maximum amplitude of the differential tracking signal the effective width of the servo-track portions should be of the order of half the track period, whilst for a maximum amplitude of the integral read signal produced by the sector address areas the effective width of these areas should be of the order of one third of the track period. In accordance with the invention the concept used until now in the manufacture of the master disc for such record-carrier bodies, of recording both the sector addresses and the servo-track portions by means of one radiation spot, is abandoned and two radiation spots of different dimensions are used, so that the sector address areas and the servo-track portions each can be given their optimum widths, which differ from each other.

It is to be noted that European Patent Application no. 0,100,995 describes a record-carrier body provided with servo-track portions in the form of grooves and sector addresses in the form of pits.In said Patent Application it is stated that the width of the servo grooves may be equal to or larger than the width of the pits in the sector addresses. However, said European Patent Application

deals with th probl m that at th l cati n f th sector addres a satisfactory tracking by means of differential method is not possible if the pits of the sector addresses have a depth of $\lambda/4$, which corresponds to a phase depth of 180^{o} for pits having straight walls. Here, λ is the wavelength of the radiation beam used for reading the addresses and recording the user information. In order to solve this problem it is proposed to give the pits of the sector addresses the same depth as the servo grooves, <u>i.e.</u> the depth of the order of an odd multiple of $\lambda/8$, which corresponds to a phase depth of approximately 90^{o} for pits having straight walls. In this record-carrier body the phase depths of the pits and the grooves therefore are not different as in the record carrier body in accordance with the present invention. Moreover, and which is even more important, the ratio between the widths of the servo-track portions and the sector-address areas in the record carrier body in accordance with European Patent Application no. 0,100,995 differs from that in the record-carrier body proposed in the present Application.

In European Patent Application no. 0,100,995 the widths are expressed as the half-intensity width W_o of the scanning spot. The servo grooves have a width of $W_o/2$ and the pits of the sector addresses have a width of $W_o/3$, so that the width of the servo grooves is approximately 1.5 times the width of the pits. In a record carrier body in accordance with a preferred embodiment of the invention, which is intended to be scanned by means of a radiation spot whose half-intensity width is approximately 800 nm, the width of the servo-track portions is approximately 1200 nm, or $3/2.W_o$, and that of the pits is approximately 600 nm, or $3/4.W_o$. Further, European Patent Application no. 0,100,995 does not mention anything about th r lation b tw n th maximum track width and the track p riod.

In accordanc with a second asp ct of the invention

tw radiati n sp ts, for recording th serv -track areas and the sect r addresses r sp ctively, are utiliz d in order to increase the amplitude of the signal obtained during the subsequent read-out of the information recorded by the user. In accordance with this aspect a record carrier in accordance with the invention is characterized in that the servo-track portions constitute continuous tracks and the sector addresses are situated between servo tracks which are situated adjacent each other in a direction transverse to the track direction.

In this record carrier body a user does not record the information in the servo-track portions, as was customary until now, but in the lands between the servo tracks, i.e. on flat parts of the recording layer. As a result of this, the information areas, which comprise melted-away portions of the recording layer, can be detected better than when these areas are situated in the servo grooves.

The invention further relates to apparatus for forming a structure of sector addresses and servo-track areas on a photo-sensitive layer of a master disc. This apparatus, which comprises a radiation-source system for producing two radiation beams, a separate intensity modulator for each of the beams, and an objective system for focussing the beams to form two radiation spots of different dimensions, is characterized in that the smaller radiation spot is employed for recording the sector addresses and the larger radiation spot for recording the servo-track portions.

It is to be noted that it is known from United States Patent Specification no. 4,027,330 to employ two radiation spots for simultaneously recording information areas and a servo track. In accordance with this United States Patent Specification, however, the wider radiation sp t is employed for recording broader informati n areas and th narrower radiati n sp t for r cording a narr w s rv track. The information ar as hav th form of l cally widened portions of th serv track and are distributed ov r th

ntir l ngth of the s rv track and hen e d n t c nstitute s ctor-address ar as.

The apparatus in accordance with the invention may be characterized further in that, viewed in a direction transverse to the longitudinal direction ofthe servo-track portions to be recorded, the two radiation spots have the same position.

However, preferably, the apparatus is characterzed further in that, viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded, the two radiation spots are shifted relative to one another.

The sector addresses are then recorded between the turns of the servo track. The user information is subsequently also recorded in these lands, which enables the information areas to be read more effectively by means of the integral read method.

For reading the sector addresses and recording information in a record carrier body having continous servo tracks and sector addresses situated between these tracks, a user must employ a write-read apparatus modified in accordance with the invention, This apparatus, which comprises a radiation-source system for producing a single or double write-read beam, an intensity modulator arranged in the path of the beam, and an objective system for focussing the beam to form a single or double write/read spot, is characterized in that there is provided an auxiliary beam for the purpose of tracking, which auxiliary beam is focused by means of the objective system to form an auxiliary radiation spot which, viewed in a direction transverse to the direction of a servo track, is shifted relative to the single or double write/read spot over the distance equal to half the track period in a direction transverseto the track direction.

Aft r th us r has r cord d inf rmation in the r cord-carri r body in accordanc with the pr f rred emb dim nt, a record carri r is obtained which is

characteriz d by continous servo tracks b tw n which sector addresses are situated, information ar as being recorded between successive sector addresses, viewed in the track direction.

Embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings. In the drawings :

Fig. 1 is a plan view of a part of a record carrier body in accordance with a first embodiment of the invention,

Fig. 2 shows two adjacent sector addresses of this record carrier body to an enlarged scale,

Fig. 3 is a radial sectional view of a part of said record carrier body at a location outside the sector addresses,

Fig. 4 is a radial sectional view of a part of said record carrier body at the location of the sector addresses,

Fig. 5 is a tangential sectional view of a part of said record carrier body,

Fig. 6 is a plan view of a part of a record carrier body in accordance with a preferred embodiment of the invention,

Fig. 7 is a radial sectional view of a part of said record carrierbody at the location of sector addresses,

Fig. 8 is a tangential sectional view of a part of said record carrier body,

Figure 9 shows an apparatus for recording the sector addresses and the servo-track portions, in accordance with a first embodiment of the invention,

Fig. 10 shows a part of such an appratus in accordance with a second embodiment, and

Fig. 11 shows a combined write/read apparatus for recording and reading information in a record-carrier body in accordanc with the invention.

The r cord-carrier body 1 as shown in Figur 1 compris s a track 10, for xample a spiral track, of which

Figur 1 sh ws only two of th multitud of turns. Each turn of the track is divided into a large number of sectors, for example 64 of 128. Each sector comprises a servo-track portion 13, in which a user can record information, and a sector address 12, in which inter alia the address of the associated servo-track portion 13 is encoded in digital form in optically readable areas 15 shown in Figure 2. Both these areas and the servo-track portions 13 can be detected optically, so that before a block of information is recorded the desired address can be detected and, both before and during recording, steps can be taken to ensure that a write spot accurately follows the servo-track portions. The record-carrier body 1 has a recording layer in which an optically detectable change isproduced when it is exposed to radiation of sufficiently high intensity.

The method by which and the apparatus by means of which the addresses are read and the servo track portions are followed during the recording of the information by the user and the manner in which the recorded user information can be read fall beyond the scope of the present invention and are therefore not described here. For these subjects reference is made to United States Patent Specification no. 4,363,116.

Figure 2 shows part of two radially adjacent sectors of the track 10. As is shown in this Figure, the sector addresses are formed by areas 15 which alternate with intermediate areas 16 in the track direction. Between the consecutive turns of the track 10 lands 14 are situated at the same level as the intermediate areas 16. The servo track portions may comprise ridges situated on the surface of the intermediate areas 16 and the lands 14 or, as is shown in Figure 3, grooves r cess d in this surfac . In the latt r cas the s ctor address ar as comprise pits in said surfac , which ar deep r than th s rv gr ves, as can be s n in Figure 4.

It is to b noted that for th sak of clarity th

widths of the track 10 and of the lands 14 in Figure 1 have been exaggerated in comparison with the total surface areas of the record carrier. In reality the record carrier body has a diameter of, for example, approximately 30 cm and the radial period P_r, i.e. the period of the track structure in the radial direction r, is, for example, 1600 nm. The length of the sector addresses has also been exaggerated in comparison with the servo track portions 13. In practice, the length of the portions 13 is, for example of the order of magnitude of 10 to 100 times the length of the sector addresses 12.

Figure 3 is a radial sectional view of a part of the record carrier body, taken on the line 3-3' in Figure 1, at a location where only servo-track portions 13 are situated. The servo-track portions 13 comprise grooves recessed in the surfaces of the lands 14, which grooves can be followed by means of the differential method. As set forth in British Patent Specification no. 2,034,097 these grooves have a phase depth of the order of 90°. These grooves are shallow and their walls have a large angle of inclination θ_1, of the order of 80°. The substrate 17 carries a thin recording layer 18. This layer may be a reflecting layer, comprising, for example, bismuth or tellurium as its principal element. The track structure is then scanned with a beam which is projected from underneath and which traverses the substrate, as is indicated by the arrow 19. Moreover, a protective coating 20 may be provided on the recording layer 18.

Figure 4 is a radial sectional view taken on the line 4-4' in Figure 1, showing a part of the record-carrier body at the location where the sector addresses are situated. It has been assumed that at the location where the sectional view has been taken two areas 15 are situated adjacent each other in the radial direction. As will become apparent from a comparison with Figure 3, these areas are deeper than the servo trackportions, whilst the angle of inclination θ_2 is, for example, of the order of 30° to 60°.

Fig. 5 is a tangential sectional view of a part of the record-carrier body, taken on the line 5-5' in Figure 1. As Figure 5 shows, each sector address comprises an address portion 12a and a synchronizing portion 12b, which each comprise a plurality of pits 15 of uniform dimensions, recessed in the substrate. The sequence of pits in the portion 12a represents the address information. The pits in the portion 12b have a fixed spatial frequency and upon read-out they produce a clock signal for controlling, for example, the clock frequency of a signal source which serves for modulating the amplitude of the write beam with which the user records the information.

By means of a write beam whose intensity is modulated in conformity with the user information to be recorded, for example, pits 22 can be melted in the recording layer at the location of the track portions 13, so that information areas are formed which have a different reflection coefficient than the surrounding areas. After the information has been recorded the user has a record carrier in which the servo-track portions 13 and the sector addresses 12 constitute a phase structure, whilst the user information has been recorded in the form of, for example, an amplitude structure.

In accordance with the invention, as will be apparent from Figure 1 and a comparison of Figures 3 and 4, the maximum width $W_{max.1}$ of the servo track portions is at least twice the maximum width $W_{max.2}$ of the sector-address areas and W_{max1} is larger than half the track period in the radial direction (P_r). In a record carrier for which P_r = 1600 nm and which is intended to be scanned with a radiation spot whose half-intensity value is approximately 800 nm $W_{max.1}$ is approximately 1200 nm and $W_{max.2}$ is approximately 600 nm. The larger width of the servo-track portions ensures that the differential tracking signal has a better signal amplitude than the tracking signal obtained from record-carrier bodies known until now, in which the maximum track width is equal to the maximum width of the sector address areas and is, for example, 600 nm.

An important advantage is, moreover, that for the specified width of the servo track portions 13 the information areas 22 recorded in these portions by the user can be read better by means of the integral method than such track portions 13 having a smaller width. The last-mentioned effect can be explained from the fact that the information areas 22, which differ from their surrounding area in that they have a different coefficient of reflection, can be detected better when the groove portions 13 are wider and bear greater resemblance to the flat portions of the recording layer.

The optimum value of the maximum track width for differential tracking and for integral reading from the sector-address areas provided by the invention, is the result of inventive use of insights obtained by vectorial diffraction computations. These show that as the servo-track portion becomes wider the amplitudes of the second and higher even diffraction orders decrease and, if the track depth remains the same, the amplitude of a first-order sub-beam increases as a result of the larger volume of the servo groove or ridge, and that as the maximum track width more closely approximates to the radial period of the track structure the phase depth will come closer to the optimum value of 90°, even for larger depths of the servo track. It has been found that a specific value for the maximum track width can be specified above which the amplitude of the differential tracking signal hardly increases. For a record carrier body which has a period P_r of the order of 1600 nm and which is scanned with a radiation spot whose half-intensity value is approximately 800 nm, said value is approximately 1200 nm.

The vectorial diffraction theory teaches that the differential tracking signal is ideal for an effective track width equal to approximately half the radial track period. For V-shaped servo grooves this means that the maximum groove width is substantially equal to the track period, so that the grooves would adjoin each other. From the point of view of manufacturing technology this is

undesirable. How ver, it is also found that for d viations f th rder of 25% fr m th ideal track width a very acceptable tracking signal can be obtained. Therefore, for practical versions of the record carrier body in accordance with the invention the optimum value for the maximum width of the servo-track portions is of the order of 75% of the radial track period. Deviations of the order of 20% from this optimum value are permissible.

Figure 6 shows a record carrier body in accordance with a preferred embodiment of the invention. In this embodiment the servo-track portions adjoin each other in a tangential direction and constitute a continous spiral track or continuous concentric tracks 13. The sector addresses are now situated between the turns of the servo track 13. The optimum value for the maximum width of the servo track 13 is again of the order of 75% of the radial period P_r, and the maximum track width is again at least twice the maximum width of the sector-address areas.

Figure 7 is a radial sectional view of a part of this record-carrier body, taken on the line 7-7' in Figure 6 at the location where the sector addresses are situated. It is assumed that at the location where this sectional view is taken two areas 15 adjoin each other in a radial direction. After the description of the first embodiment with reference to the Figures 3 and 4, Fig. 7 is self-explanatory. Figure 8 is a tangential sectional view of a part of the record-carrier body, taken on the line 8-8' in Figure 6. This Figure also requires no further explanation.

In the record-carrier body shown in Figure 6 the information areas 22 are recorded by the user in the lands between two sero-track portions 13 and between two sector addresses 12. Since the surface for recording the information areas is now entirely flat, these areas can b r ad ven b tt r by m ans of th int gral m thod than in the cas wher th information ar as are r corded in

the wide servo track portions of the record carrier body 1 shown in Figure 1.

It is to be noted that the recording of the user-information between the servo grooves or ridges need not be combined with a wider servo groove, but may also be applied to a record-carrier body with a narrower servo groove. Recording the information areas between the servo grooves or ridges then also has the advantage that these areas can be read more effectively.

Figure 9 shows the basic diagram of an apparatus by means of which the sector addresses and the servo-track portions on a master disc can be produced. In this Figure the reference numeral 30 denotes the substrate of the master disc, for example a glass substrate. This substrate carries a photo-sensitive layer 31, whose thickness has been selected in such a way that the sector-address areas, formed after the development of the photo-sensitive layer, have a depth or height which is adapted to the wavelength of the beam with which the record-carrier body is to be scanned in order to obtain the correct phase depth. A radiation-source system 33 may comprise one laser or two separate lasers 34 and 35, for example argon-ion lasers. This system produces two radiation beams b_1 and b_2, of which b_1 serves for recording the sector addresses and b_2 for recording the servo-track portions. The narrow beams are widened, for example by means of telescopes comprising lenses 36, 37 and 39, 40 respectively, the beam b_1 being widened more than the beam b_2. Thus, the beam b_1 is given such a width that it fills a substantial part of the entrance pupil of the objective systems 45. After having traversed its telescope the beam b_2 is coupled into the path of the beam b_1 by the mirror 42 and a beam splitter, for example in the form of a beam-splitting mirror 43. A mirror 44 reflects the two beams to the objective system 45, which focusses each of the beams to form radiation spits V_1 and V_2, respectively. Since the beam b_1 fillsa substantial part of the pupil of the objective system, this beam is focussed to a minimal diffraction-

limited radiation spot. The beam b_2, which fills a small part of the pupil, is focussed to form a larger radiation spot V_2.

By rotating the disc about the axis 32 the radiation spots V_1 and V_2 will describe one turn on the disc. For recording a spiral track or a plurality of concentric tracks the radiation spots and the disc should be moved in a radial direction relative to each other either with a constant velocity or stepwise. For this purpose, the mirror 44 and the objective system 45 may be accommodated in a housing which is moved in the direction indicated by the arrow 46.

Modulators 47 and 49, for example acousto-optical modulators, are arranged in the radiation paths of the beam b_1 and the beam b_2, respectively, to switch the intensity of the relevant beam in conformity with the signal applied to the terminals 48, 48' and 50, 50', respectively. When the sector addresses are recorded the modulator 47 is switched between a high level and a zero level at a high frequency. In the present apparatus the modulator 49 is then set to the zero level. During the recording of the servo-track portions the modulator 47 is set to the zero level and the modulator 49 operates continuously at an intermediate level.

The exposure locally increases the solubility of the photo-sensitive layer. The desired relief pattern is obtained by a selective removal of the exposed photo-sensitive material in a development process. The depth and the width of the servo groove are determined by the intensity of the beam b_2 and the width of the radiation spot V_2, respectively. After the master disc has been developed it may be coated with, for example, a silver layer. Subsequently, this disc may be used in known manner for the manufacture of matrices, which are employed for the manufacture of a large number of replicas.

If the chief rays of the beams b_1 and b_2 are situated in the same X-Y plane, the radiation spots V_1 and V_2 are superimposed, as shown in the inset in the right-

hand part of Figur 9, assuming that th mirrors 42 and 43 are disposed at angles of 45° to said chief rays. Alternatively, the radiation spots may be shifted in the tangential direction of the disc, i.e. in the Y-direction in Figure 9, in such a way that the radiation spot V_1 is situated in front. For this purpose the radiation paths of the beams b_1 and b_2 should be shifted slightly relative to each other in the Y-direction.

For recording continous servo tracks and sector addresses between the turns of the servo tracks it is in principle possible to use an arrangement similar to that shown in Figure 9, in which the modulator 49 is always at the intermediate level and the modulator 47 is switched between the high level and the zero level with a high frequency when the sector addresses are being recorded. The radial shift of the radiation spots V_1 and V_2 relative to each other can be obtained, for example, by positioning the mirror 42 at an angle which differs slightly from 45° relative to the chief ray of the beam b_2, as is shown in Figure 10. This Figure shows only that part of the radiation path where the beams are given different directions, i.e. the part beginning at the mirror 42.

Figures 9 and 10 show the basic diagram of the apparatus for recording the sector addresses and the servo-track portions, in which apparatus a number of variants are possible. For example, the radiation-source sy stem may comprise only one laser followed by a beam splitter. In order to minimize the loss of intensity this beam splitter and the beam splitter 43 are preferably polarisation-dependent beam splitters and the single radiation source, or the double radiation source 34, 35, should be capable of producing two beams which are polarised perpendicularly to each oth r. It is also possibl to mploy wavel ngth-s lective beam splitters in conjuncti n with a singl r double radiation source, mitting tw diff rent wavel ngths. A shift of the radiation spots V_1 and V_2 in a radial direction, the X-direction in Figur 9, can als be

obtained by an optical wedge in the path of the beam b_2, the mirror 42 extending parallel to the beam-splitting mirror 43.

The user of the record-carrier body should have a combined recording/read apparatus at his disposal for recording information and reading this information, and for reading the sector addresses both during recording and during information reading. Such combined apparatus are known, for example from United States Patent Specification no. 4,363,116 and British Patent Specification no. 2,097,150. The known apparatus are suitable for use in conjunction with a record-carrier body in which the sector addresses occupy the same radial positions as the associated servo-track portions. For a record-carrier body in which the servo-track portions constitute continuous tracks and the sector addresses ar e situated between the turns of the servo track, the tracking systemin the known write/read apparatus may be modified in such a way that the scanning spot is held at a constant distance from the servo track in a way similar to that described in British Patent Specification 2,013,489 for a record carrier with deep and shallow tracks. Another possibility is to provide the known write/read apparatus with means for the formation of an additional radiation spot for the purpose of tracking.

Figure 11 shows an example of such an apparatus. This Figure only shows the elements of the tracking system. The element 60 is a radiation source, for example a diode laser, which produces a beam b_3. The lenses b_1 and b_2 constitute a beam-widening telescope which ensures that the beam b_3 fills the pupil of theobjective system 67 correctly. Instead of the telescope a lens may be used, which is arranged between the mirror 65 and the objective system 67. The beam reaches this objective system after reflections from the mirror 63, the beam-splitting mirror 64 and the mirror 65. The objective systemfocusses the beam b_3 to form a diffraction-limited radiation spot V_3 on the recording layer 18 of the record-carrier body 1. This body can be rotated about an axis 68, and the mirror 65 and the objective system 67 can be moved together in a radial direction relative to the record-carrier body, the X-direction in Figure 11, as indicated by the mirror 75.

The mirror 63 and the beam-splitting mirror 65 serve to couple the auxiliary beam b_3 into the mainradiation path of the apparatus, so that all the beams pass through the same objective system. The main radiation path is represented schematically by a broad beam $b_{0,1}$ ($b_{0,2}$) indicated by double arrows. The block 69 together with the mirror 66 and the objective system 67 constitute the known part of the apparatus. As is described in United States Patent Specification no. 4,363,116, it is possible to use only one radiation spot both for recording and reading. In that case the block 69 comprises one radiation source, for example a diode laser, a beam-widening and collimating lens system, a modulator, a radiation-sensitive detection syste, and a beam splitter for diverting the radiation which has been reflected by the record carrier body to the detection system which supplies the address signals and the information signals.

Another version of the block 69 produces two radiation beams $b_{0,1}$ and $b_{0,2}$ which are focussed by the objective system to form two radiation spots V_1 and V_2 which are shifted relative to each other in the tangential direction of the record-carrier body, i.e. in the Y-direction in Figure 11. The radiation spots V_1, V_2 and V_3 have the same dimensions. In the present example the block 69 comprises, for example, two diode lasers, a beam splitter for recombining the two laser beams after one of them has passed through a modulator, a second beam splitter for diverting the beams reflected by the record-carrier body, a third beam splitter for separating the two beams, and a separate detection system for each of the beams. The beam $b_{0,1}$, which forms the radiation spot V_1, serves for reading the clock signals and the addresses and for recording the information, and the beam $b_{0,2}$, which forms the radiation spot V_2, is employed for reading the information. For further details about a block 69 which is capable of producing one or two radiation beams reference is made to the United States Patent Specification no. 4,363,116 and British Patent Specification no. 2,097,150, respectively.

The auxiliary beam b_3 is reflected by the record-carrier body and returns along itself until it reaches a beam splitter 70. This beam splitter reflects a part of the beam b_3 to a radiation-sensitive detection system comprising two detectors 71 and 72. The output signals of these detectors are applied to a differential amplifier 73. The output signal S_r of this amplifier contains information about the magnitude and the direction of a deviation between the centre of the radiation spot V_3 and the central axis of the servo track. This signal is employed for correcting the radial position of the radiation spot V_3 and those of the radiation spots V_1 and V_2, for example by pivoting the mirror 65 in the direction indicated by the arrow 66 by means of an actuator 74 to which the signal S_r is applied.

CLAIMS

1. A record-carrier body in which a user can record information by means of optical radiation, which record-carrier body comprises a substrate and a recording layer on said substrate and which has been provided with a pre-formed and optically detectable relief structure of servo track portions and sector addresses in which address information about associated recordable portions of the record-carrier body is contained in the form of optically detectable areas which alternate with intermediate areas, which areas in the sector addresses have another phase depth than the servo-track portions, characterized in that the maximum width of the servo-track portions is at least 60% of the track period, transverse to the track direction, and is at least of the order of twice the maximum width of the sector-address areas.

2. A record-carrier body, in which a user can record information by means of optical radiation, which record carrier body comprises a substrate and a recording layer on said substrate and which has been provided with a preformed and optically detectable relief structure of servo-track portions and sector addresses in which address information about associated recordable portions of the record-carrier body is contained in the form of optically detectable areas which alternate with intermediate areas, which areas in the sector addresses have another phase depth than the servo-track portions, characterized in that the serwo-track portions constitute continuous tracks and the s ctor addr ss s ar situat d betw n s rv tracks which are situat d adjac nt ach ther in a directi n transv rse to th track dir ction.

3. An apparatus f r f rming a structure similar to th structur of s rvo-track porti ns and s ct r addresses of th r cord-carri r body as claimed in Claim 1

r 2, comprising a radiati nsource syst m f r producing tw radiation beams, a separate intensity modulator for each of the beams, and an objective system for focussing the beams to form two radiation spots of different dimensions, characterized in that the smaller radiation spot is employed for recording the sector addresses and the larger radiation spot for recording the servo-track portions.

4. An apparatus as claimed in Claim 3, characterized in that the two radiation spots have the same position viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded.

5. An apparatus as claimed in Claim 3, characterized in that the two radiation spots are shifted relative to each other viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded.

6. An apparatus for recording and reading information in a record-carrier body as claimed in Claim 2, which apparatus comprises a radiation-source system for producing a single or double write/read beam, an intensity modulator arranged in the path of the beam, and an objectie system for focussing the beam to form a single or double write/read spot, characterized in that there is provided an auxiliary beam for the purpose of tracking, which auxiliary beam is focussed by means of the objective system to form an auxiliary radiation spot which, viewed in a direction transverse to the direction of a servo track, is shifted relative to the single or double write/read spot over a distance equal to half the track period in a direction transverse to the track direction.

7. A record carrier comprising a record-carrier body as claimed in Claim 2, in which information has been recorded, characterized by continuous servo tracks between which sector addresses are situated, information areasbeing recorded between successive sector addresses, viewed in the track direction.

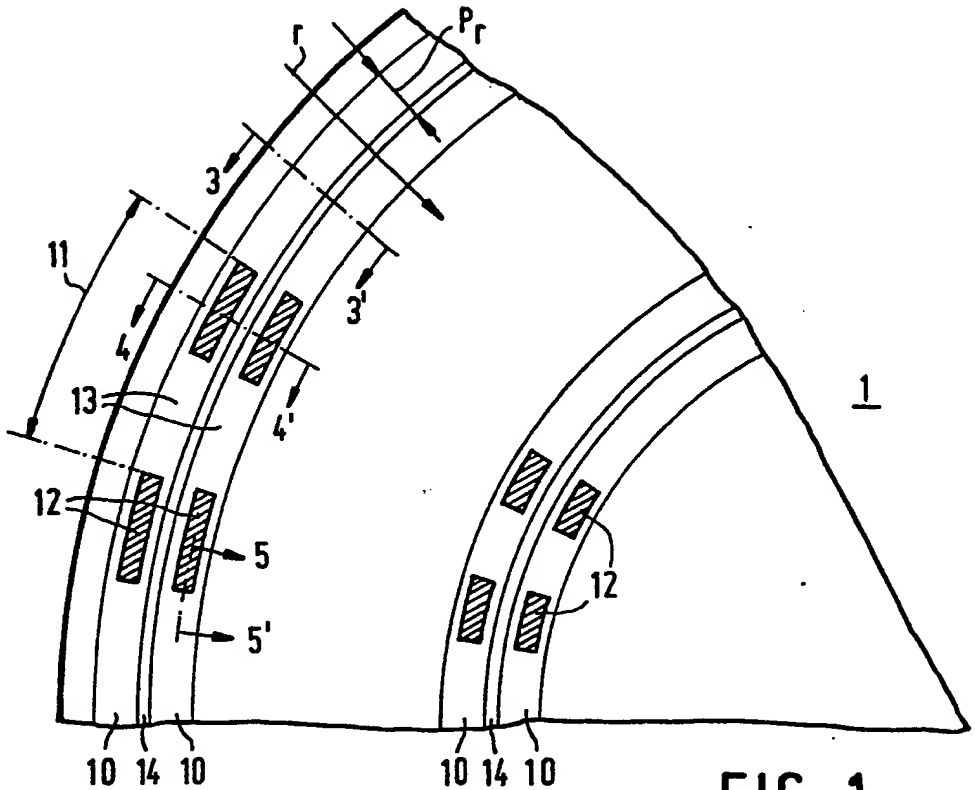

FIG. 1

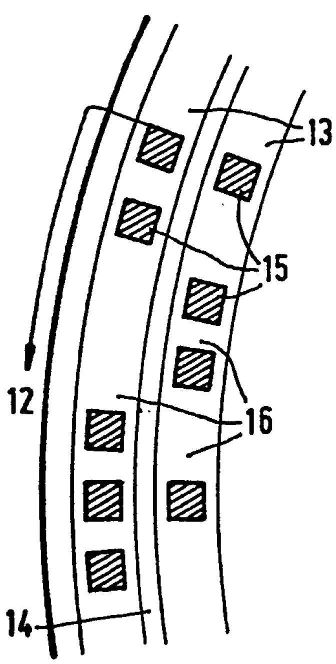

FIG.2

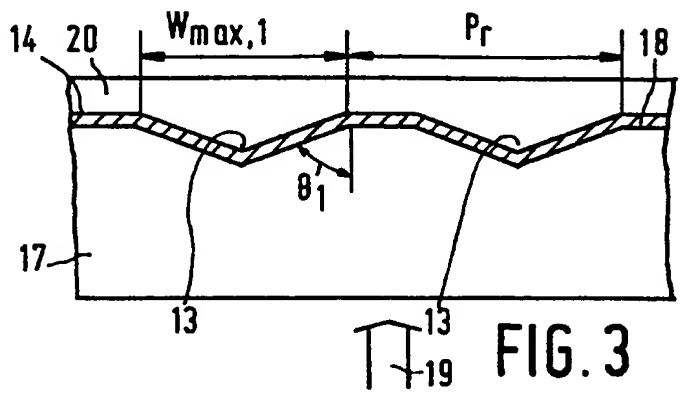

FIG. 3

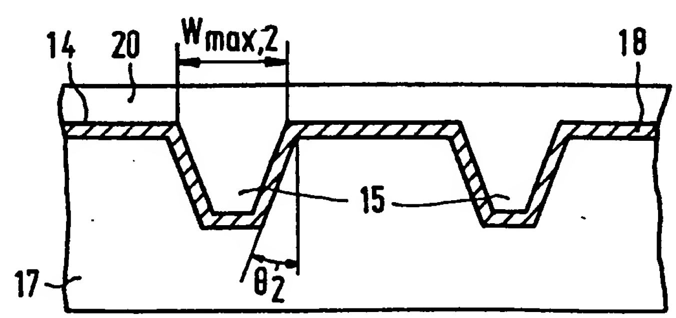

FIG.4

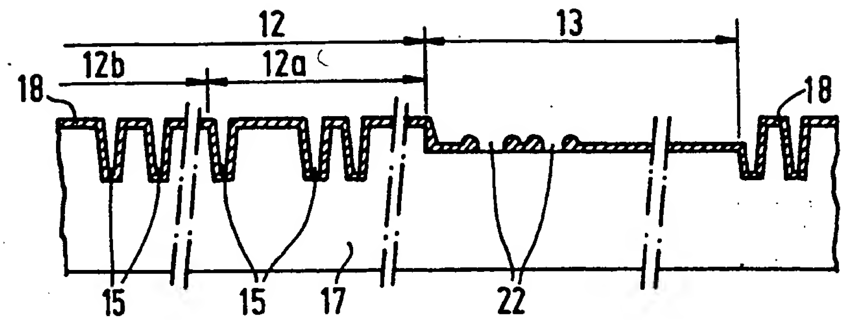

FIG.5

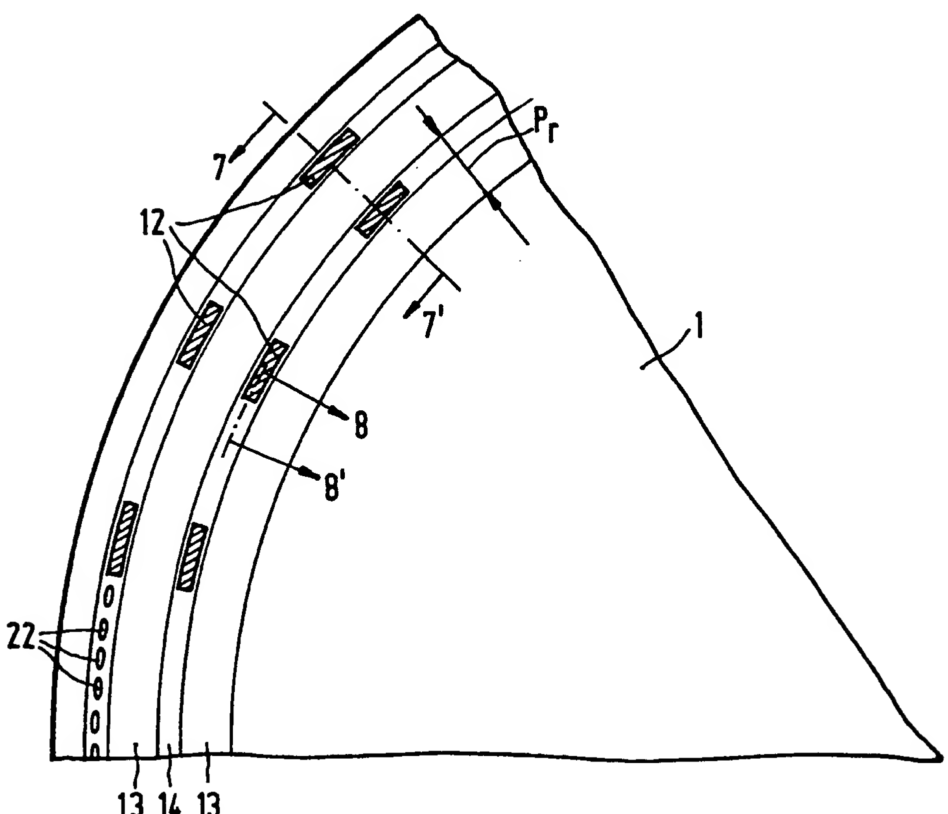

FIG.6

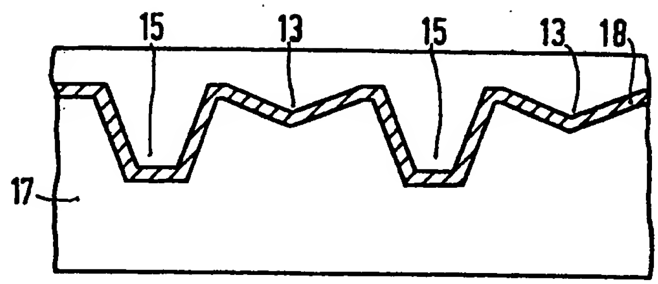

FIG. 7

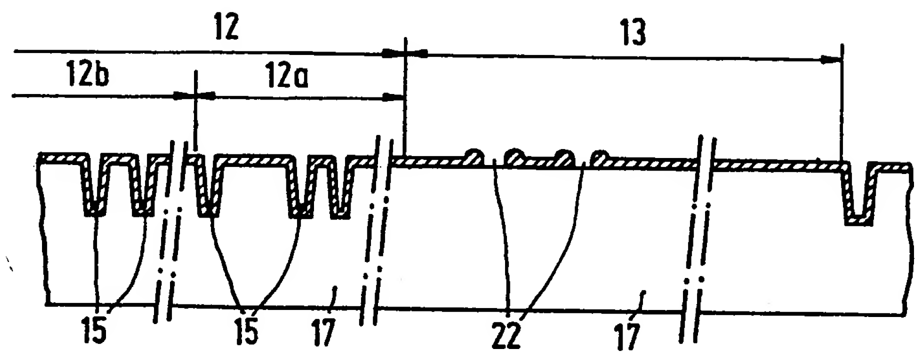

FIG. 8

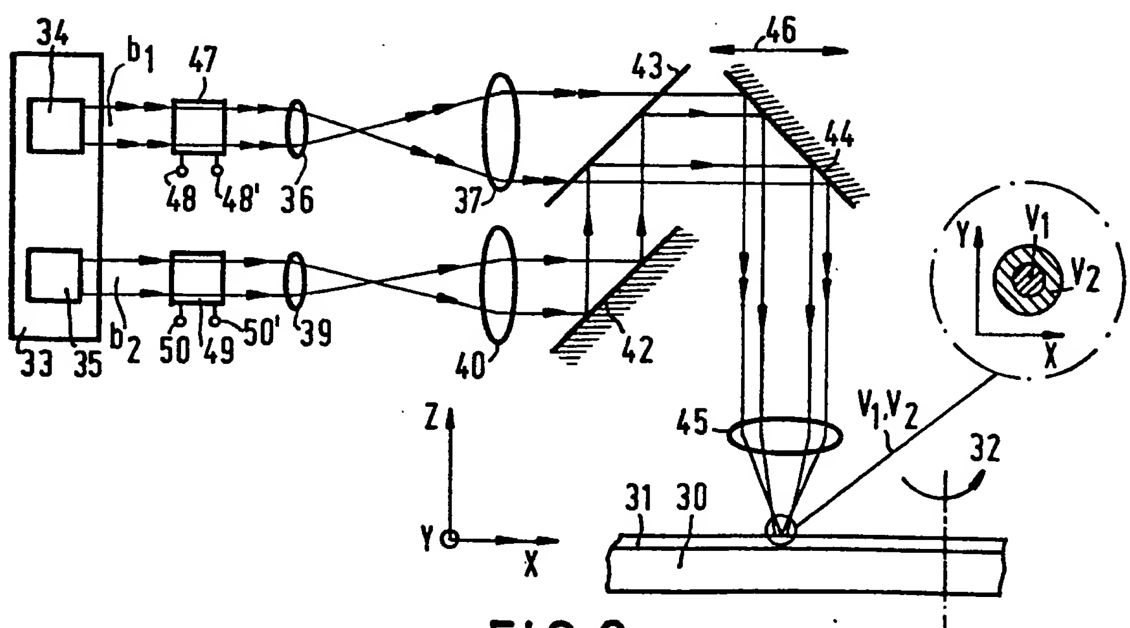

FIG.9

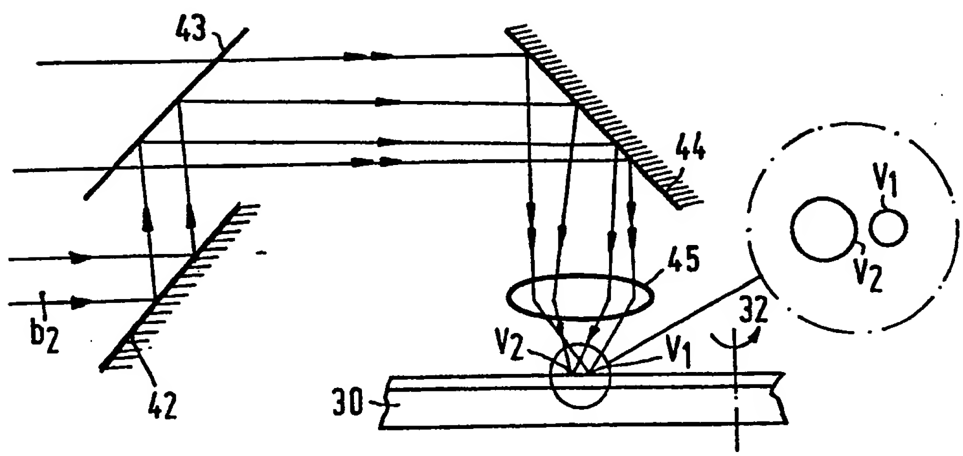
43
44
V1
V2
45
32
b2
V2
V1
42
30

FIG.10

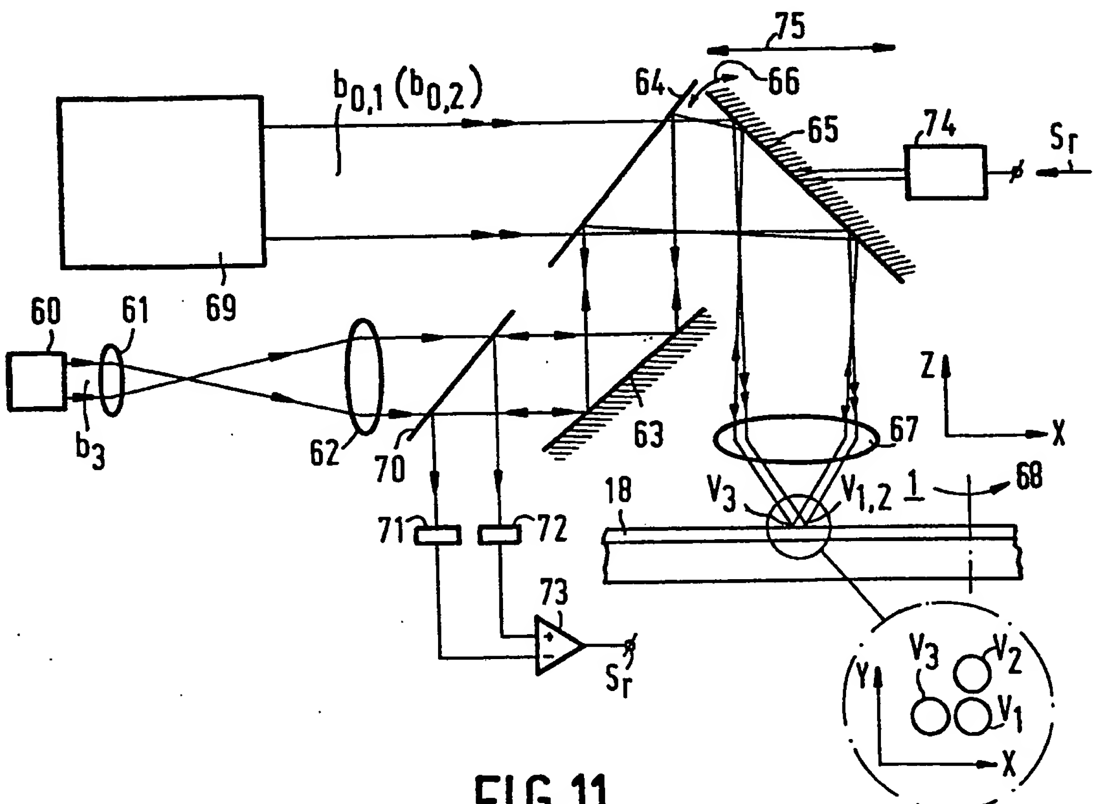
75
b0,1 (b0,2)
64
66
65
74
Sr
69
60
61
b3
62
70
63
Z
X
67
71
72
73
Sr
18
V3
V1,2
1
68
Y
V3
V2
V1
X

FIG.11

0189948

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 20 0024

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	PROCEEDINGS OF SPIE-THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING, OPTICAL STORAGE MEDIA, 6th-10th June 1983, Arlington, Virginia, US, vol. 420, pages 86-95, SPIE, Washington, US; J.A. CORNET: "Deformation recording process in polymer-metal bilayers and its use for optical storage" * Figure 5 *	2,7	G 11 B 7/013 G 11 B 7/24 G 11 B 7/26 G 11 B 7/12 G 11 B 7/095 G 11 B 23/00
A	Idem ---	1	
A	EP-A-0 099 085 (TOKYO SHIBAURA DENKI K.K.) * Page 3, line 35 - page 6, line 18; page 7, lines 2-13; figures 1-6,8 * ---	1-4	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
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A	EP-A-0 108 258 (TOKYO SHIBAURA DENKI K.K.) * Whole document * --- -/-	1-4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28-04-1986	DAALMANS F.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
P : intermediate document

T : theory r principle underlying the invention
E : earlier patent document, but published n, r after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 20 0024

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	GB-A-2 058 434 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * Page 3, lines 20-107; page 4, lines 66-85; page 5, line 128 - page 6, line 11; page 10, line 119 - page 11, line 60; figures 16,17 * ---	1,2	
A	PATENTS ABSTRACTS OF JAPAN, vol. 9, no. 48 (P-338) [1771], 28th February 1981, page 12 P 338; & JP - A - 59 185 037 (MATSUSHITA DENKI SANGYO K.K.) 20-10-1984 * Abstract * ---	5,6	
A	GB-A-2 016 747 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * Page 3, lines 10-94; page 6, lines 18-105 * ---	1,2,5, 6	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-A-2 352 669 (CANON K.K.) * Whole document * ---	3,5	
A	EP-A-0 032 271 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * Page 5, line 4 - page 9, line 14; page 12, line 34 - page 17, line 1; page 23, line 12 - page 25, line 11 * ---	1-3,6	
A	US-A-4 385 372 (DREXLER) * Whole document * --- -/-	1,2	

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Place of search	Date of completion of the search	Examiner
THE HAGUE	28-04-1986	DAALMANS F.J.

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0189948

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Application number

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Page 3

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl.4)
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A,D	EP-A-0 100 995 (TOKYO SHIBAURA DENKI K.K.) * Whole document * ---	1,2	
P,X	GB-A-2 156 139 (PIONEER ELECTRONIC CORP.) * Page 1, line 76 - page 2, line 86 * ---	3,5	
A	GB-A-2 018 489 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * Whole document * -----	1,2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)

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THE HAGUE	28-04-1986	DAALMANS F.J.

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(19) Europäisches Patentamt
Eur pean Patent Office
Office européen des brevets

(11) Publication number: **0 189 948 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 04.04.90

(21) Application number: 86200024.7

(22) Date of filing: 09.01.86

(51) Int. Cl.[5]: G 11 B 7/013, G 11 B 7/24, G 11 B 7/26, G 11 B 7/12, G 11 B 7/095, G 11 B 23/00

(54) **Record-carrier body provided with a relief structure of optically detectable servo-track portions and sector addresses and apparatus for forming said structure.**

(30) Priority: 22.01.85 NL 8500153

(43) Date of publication of application:
06.08.86 Bulletin 86/32

(45) Publication of the grant of the patent:
04.04.90 Bulletin 90/14

(84) Designated Contracting States:
BE DE FR GB IT NL SE

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Courier Press, Leamington Spa, England.

Description

The invention relates to a record-carrier body in which a user can record information by means of optical radiation, which record-carrier body comprises a substrate and a recording layer on said substrate and which has been provided with a preformed optically detectable relief structure of servo-track portions and sector addresses in which address information about associated recordable portions of the record-carrier body is contained in the form of optically detectable areas which alternate with intermediate areas, which areas in the sector addresses have another phase depth than the servo-track portions. The invention also relates to an apparatus for forming a structure in conformity with the relief structure of sector addresses and servo-track portions of said record-carrier body.

The record-carrier body may be a circular disc-shaped substrate carrying a recording layer in which optically detectable changes can be produced by a radiation beam of sufficiently high intensity. The servo-track portions may comprise grooves recessed in the substrate surface or ridges formed on the substrate surface, and the sector-address areas may comprise pits recessed in the substrate surface or hills formed on this surface. The sector addresses may situated between successive servo track portions, viewed in the track direction, so as to form one composite track. This track extends over the entire surface area of the recording layer and is preferably a spiral track, but alternatively it may comprise a multitude of concentric tracks.

When the sector addresses and servo track portions are exposed to a radiation beam which is focused to form a small radiation spot, this beam is split into a zero-order subbeam, first-order subbeams and higher-order subbeams. Herein, phase depth is to be understood to mean the phase difference between the zero-order subbeam and a first-order subbeam. This phase depth is determined by the geometry of the sector-address areas and the servo-track portions, *inter alia* by the depth or height of these areas and track portions.

Such a record-carrier body is known *inter alia* from United States Patent Specification No. 4,363,116. As described in said Patent Specification, the servo-track portions are employed during the recording of information by the user for detecting and correcting the radial position of a radiation spot formed on the recording layer by a radiation beam. This enables the requirements imposed on the drive and guide mechanisms, for moving the write spot and the record carrier body relative to each other, to be less stringent, so that the write apparatus can be simpler and cheaper.

Preferably, the radial positi n of th radiati n spot relative to a s rvo-track portion is detect d by means of the "push-pull" or differential meth d. This meth d mpl ys two radiation-sensitive detectors, which are arranged in the path of the radiation beam issuing from the rec rd carrier body and which receive radially different portions of this beam. The difference betw en the output signals of the two detectors contains information about the radial position of the radiation spot relative to the servo-track portion. If said output signals are equal, the centre of the radiation spot coincides with the central axis of the servo-track portion. The differential tracking method may be employed only if the servo grooves have such a depth or the servo ridges have such a height that their phase depth is of the order of 90°.

The sector-address areas are read using the "Central-Aperture" or integral method. In accordance with this method the variation of the overall intensity of the radiation originating from th record carrier body and traversing an objective system is detected by means of a single detector arranged on the optical axis or by means of the two detectors employed for tracking, whose output signals are added to each other. For optimum read-out of the sector addresses the areas therein should have a phase depth of approximately 180°.

It has been found that, in addition to the phase depth, the width, measured in the direction transverse to the track direction, of the servo-track portions and the sector-address areas also has a substantial influence on the amplitude of the signals obtained when the user information is recorded. In the record-carrier body in accordance with United States Patent Specification No. 4,363,116, which is intended to be scanned by means of a radiation spot whose half-intensity value is approximately 800 nm, the servo-track portions and the sector-address areas have a width of approximately 600 nm, whilst the period, transverse to the track direction, of the track structure is approximately 1600 nm. The half-intensity diameter of a radiation spot is equal to the distance between two points where the intensity is half the intensity in the centre of th radiation spot. By means of the known record-carrier body it is possible to obtain a differential tracking signal of moderate signal amplitude.

It is an object of the invention to provide a record-carrier body which, when scanned for th purpose of information recording, produces a differential tracking signal of substantially higher signal amplitude. It is another object of the invention to obtain an improved information signal of higher signal amplitude when the information areas recorded by the user are read in accordance with the integral read method.

The record-carrier body according to the invention is characterized in that the maximum width of the servo-track portions is at least 60% of the track period, transverse to the track direction, and is at least of the order of twice the maximum width of the sector-address areas.

The use of th c nc pt "maximum width" is related to the fact that the servo grooves or ridges and the sector-address pits or hills need n t hav perpendicular walls, but in practice g nerally hav dolique walls. Th maximum width is th n the width at th l cation of the recording-layer

surface which is rem te from the substrat . Apart from a maximum width the s rvo groov s and sect r-address pits also have an effective width. The shall w servo gro v s are g nerally V-shap d in cross-section. For such a groove shape the geometrical effective width is approximately half the maximum width. The deeper pits in the sector addresses are frequently trapezoidal. For such pits the effective width is equal to half the sum of the maximum width and the minimum width.

The invention is based on the recognition of the fact that for a maximum amplitude of the differential tracking signal the effective width of the servo-track portions should be of the order of half the track period, whilst for a maximum amplitude of the integral read signal produced by the sector address areas the effective width of these areas should be of the order of one third of the track period. In accordance with the invention the concept used until now in the manufacture of the master disc for such record-carrier bodies, of recording both the sector addresses and the servo-track portions by means of one radiation spot, is abandoned and two radiation spots of different dimensions are used, so that the sector address areas and the servo-track portions each can be given their optimum widths, which differ from each other.

It is to be noted that European Patent Application No. 0,100,995 describes a record-carrier body provided with servo-track portions in the form of grooves and sector addresses in the form of pits. In said Patent Application it is stated that the width of the servo grooves may be equal to or larger than the width of the pits in the sector addresses. However, said European Patent Application deals with the problem that at the location of the sector address a satisfactory tracking by means of differential method is not possible if the pits of the sector addresses have a depth of $\lambda/4$, which corresponds to a phase depth of 180° for pits having straight walls. Here, λ is the wavelength of the radiation beam used for reading the addresses and recording the user information. In order to solve this problem it is proposed to give the pits of the sector addresses the same depth as the servo grooves, *i.e.* the depth of the order of an odd multiple of $\lambda/8$, which corresponds to a phase depth of approximately 90° for pits having straight walls. In this record-carrier body the phase depths of the pits and the grooves therefore are not different as in the record carrier body in accordance with the present invention. Moreover, and which is even more important, the ratio between the widths of the servo-track portions and the sector-address areas in the record carrier body in accordance with European Patent Application No. 0,100,995 differs from that in the record-carrier body proposed in the present Application.

In European Patent Application No. 0,100,995 the widths are expressed as the half-int nsity width W_0 of the scanning spot. The servo grooves have a width of $W_0/2$ and the pits the sector addresses hav a width f $W_0/3$, so that th width f the servo grooves is approximat ly 1.5 times th width of the pits. In a record carrier b dy in accordance with a pr f rr d emb diment of the invention, which is intended to be scanned by means of a radiation spot whose half-intensity width is approximately 800 nm, the width of the servo-track portions is approximately 1200 nm, or $3/2 \cdot W_0$, and that of the pits is approximately 600 nm, or $3/4 \cdot W_0$. Further, European Patent Application No. 0,100,995 does not mention anything about the relation between the maximum track width and the track period. The two radiation spots, for recording the servo-track areas and the sector addresses respectively, may be further utilized in order to increase the amplitude of the signal obtained during the subsequent read-out of the information recorded by the user. This results in a record carrier which is characterized in that the servo-track portions constitute continuous tracks and the sector addresses are situated between servo tracks which are situated adjacent each other in a direction transverse to the track direction.

In this record carrier body a user records the information in the lands between the servo tracks, i.e. on flat parts of the recording layer. As a result of this, the information areas, which comprise melted-away portions of the recording layer, can be detected better than when these areas are situated in the servo grooves.

The invention further relates to apparatus forming a structure of sector addresses and servo-track areas on a photo-sensitive layer of a master disc. This apparatus, which comprises a radiation-source system for producing two radiation beams, a separate intensity modulator for each of the beams, and an objective system for focusing the beams to form two radiation spots of different dimensions, is characterized in that the smaller radiation spot is employed for recording the sector addresses and the larger radiation spot for recording the servo-track portions.

It is to be noted that it is known from United States Patent Specification No. 4,027,330 to employ two radiation spots for simultaneously recording information areas and a servo track. In accordance with this United States Patent Specification, however, the wider radiation spot is employed for recording broader information areas and the narrower radiation spot for recording a narrow servo track. The information areas have the form of locally widened portions of the servo track and are distributed over the entire length of the servo track and hence do not constitute sector-address areas.

The apparatus in accordance with the invention may be characterized further in that, viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded, the two radiation spots have the same position.

However, preferably, the apparatus is characterized further in that, viewed in a direction transverse to the longitudinal direction of the serv -track portions to be recorded, the tw radiation sp ts are shift d r lative t ne an ther. The sector addresses are then r corded between

the turns of th s rvo track. The user information is subsequently also recorded in th se lands, which enables th information ar as to be read more effectively by means of the integral read method.

Embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings. In the drawings:

Figure 1 is a plan view of a part of a record carrier body in accordance with a first embodiment of the invention,

Figure 2 shows two adjacent sector addresses of this record carrier body to an enlarged scale,

Figure 3 is a radial sectional view of a part of said record carrier body at a location outside the sector addresses,

Figure 4 is a radial sectional view of a part of said record carrier body at the location of the sector addresses,

Figure 5 is a tangential sectional view of a part of said record carrier body,

Figure 6 is a plan view of a part of a record carrier body in accordance with a preferred embodiment of the invention,

Figure 7 is a radial sectional view of a part of said record carrier body at the location of sector addresses,

Figure 8 is a tangential sectional view of a part of said record carrier body,

Figure 9 shows an apparatus for recording the sector addresses and the servo-track portions, in accordance with a first embodiment of the invention,

Figure 10 shows a part of such an apparatus in accordance with a second embodiment, and

Figure 11 shows a combined write/read apparatus for recording and reading information in a record-carrier body in accordance with the invention.

The record-carrier body *1* as shown in Figure 1 comprises a track 10, for example a spiral track, of which Figure 1 shows only two of the multitude of turns. Each turn of the track is divided into a large number of sectors, for example 64 of 128. Each sector comprises a servo-track portion 13, in which a user can record information, and a sector address 12, in which *inter alia* the address of the associated servo-track portion 13 is encoded in digital form in optically readable areas 15 shown in Figure 2. Both these areas and the servo-track portions 13 can be detected optically, so that before a block of information is recorded the desired address can be detected and, both before and during recording, steps can be taken to ensure that a write spot accurately follows the servo-track portions. The record-carrier body 1 has a recording layer in which an optically detectable change is pr duc d wh n it is exposed to radiati n of suffici ntly high intensity.

The method by which and the apparatus by means of which the addresses are read and the servo track portions are followed during the recording of the information by the user and the manner in which the r corded user informati n can be read fall beyond the scope f th present inventi n and are ther fore not describ d here. For these subjects reference is made to United States Patent Specification No. 4,363,116.

Figure 2 shows part of two radially adjacent sectors of the track 10. As is shown in this Figure, the sector addresses are formed by areas 15 which alternate with intermediate areas 16 in th track direction. Between the consecutive turns of the track 10 lands 14 are situated at the same level as the intermediate areas 16. The servo track portions may comprise ridges situated on th surface of the intermediate areas 16 and the lands 14 or, as is shown in Figure 3, grooves recessed in this surface. In the latter case the sector address areas comprise pits in said surface, which are deeper than the servo grooves, as can be seen in Figure 4.

It is to be noted that for the sake of clarity the widths of the track 10 and of the lands 14 in Figure 1 have been exaggerated in comparison with the total surface areas of the record carrier. In reality the record carrier body has a diameter of, f r example, approximately 30 cn and the radial period P_r, *i.e.* the period of the track structure in the radial direction r, is, for example, 1600 nm. The length of the sector addresses has also been exaggerated in comparison with the servo track portions 13. In practice, the length of the portions 13 is, for example of the order of magnitude of 10 to 100 times the length of the sector addresses 12.

Figure 3 is a radial sectional view of a part of the record carrier body, taken on the line 3—3' in Figure 1, at a location where only servo-track portions 13 are situated. The servo-track portions 13 comprise grooves recessed in the surfaces of the lands 14, which grooves can be followed by means of the differential method. As set forth in British Patent Specification No. 2,034,097 these grooves have a phase depth of the order of 90°. These grooves are shallow and their walls have a large angle of inclination θ_1, of the order of 80°. The substrate 17 carries a thin recording layer 18. This layer may be a reflecting layer, comprising, for example, bismuth or tellurium as its principal element. The track structure is then scanned with a beam which is projected from underneath and which traverses the substrate, as is indicated by the arrow 19. Moreover, a protective coating 20 may be provided on the recording layer 18.

Figure 4 is a radial sectional view taken on the line 4—4' in Figure 1, showing a part of the record-carrier body at the location where th sector addresses are situated. It has been assumed that at the location where the sectional view has been taken two areas 15 are situated adjacent each other in the radial direction. As will become apparent from a comparison with Figure 3, these areas are deeper than the servo track portions, whilst the angle of inclinati n θ_2 is, for exampl , of the order of 30° to 60°.

Figure 5 is a tangential sectional view of a part of the rec rd-carrier body, taken on the line 5—5' in Figure 1. As Figure 5 shows, each s ct r address c mprises an address p rtion 12a and a

synchr nizing p rti n 12b, which each comprise a plurality of pits 15 of uniform dimensions, recessed in the substrate. The sequence of pits in the portion 12a represent the address information. The pits in the portion 12b have a fixed spatial frequency and upon read-out they produce a clock signal for controlling, for example, the clock frequency of a signal source which serves for modulating the amplitude of the write beam with which the user records the information.

By means of a write beam whose intensity is modulated in conformity with the user information to be recorded, for example, pits 22 can be melted in the recording layer at the location of the track portions 13, so that information areas are formed which have a different reflection coefficient than the surrounding areas. After the information has been recorded the user has a record carrier in which the servo-track portions 13 and the sector addresses 12 constitute a phase structure, whilst the user information has been recorded in the form of, for example, an amplitude structure.

In accordance with the invention, as will be apparent from Figure 1 and a comparison of Figures 3 and 4, the maximum width $W_{max.1}$ of the servo track portions is at least twice the maximum width $W_{max.2}$ of the sector-address areas and W_{max1} is larger than half the track period in the radial direction (P_r). In a record carrier for which P_r=1600 nm and which is intended to be scanned with a radiation spot whose half-intensity value is approximately 800 nm $W_{max.1}$ is approximately 1200 nm and $W_{max.2}$ is approximately 600 nm. The larger width of the servo-track portions ensures that the differential tracking signal has a better signal amplitude than the tracking signal obtained from record-carrier bodies known until now, in which the maximum track width is equal to the maximum width of the sector address areas and is, for example, 600 nm. An important advantage is, moreover, that for the specified width of the servo track portions 13 the information areas 22 recorded in these portions by the user can be read better by means of the integral method than such track portions 13 having a smaller width. The last-mentioned effect can be explained from the fact that the information areas 22, which differ from their surrounding area in that they have a different coefficient of reflection, can be detected better when the groove portions 13 are wider and bear greater resemblance to the flat portions of the recording layer.

The optimum value of the maximum track width for differential tracking and for integral reading from the. sector-address areas provided by the invention, is the result of inventive use of insights obtained by vectorial diffraction computations. These show that as the servo-track portion becomes wider the amplitudes of the second and higher ev n diffraction ord rs decrease and, if the track depth remains the same, the amplitude of a first-order subbeam increases as a result of th larger v lume of the servo groove r ridge, and that as th maximum track width m r cl sely approximates to the radial period of the track structure the phase depth will c me closer to the optimum value of 90°, even for larger depths of the servo track. It has been found that a specific value for the maximum track width can be specified above which the amplitude of the differential tracking signal hardly increases. For a record carrier body which has a period P_r of the order of 1600 nm and which is scanned with a radiation spot whose half-intensity value is approximately 800 nm, said value is approximately 1200 nm.

The vectorial diffraction theory teaches that the differential tracking signal is ideal for an effective track width equal to approximately half the radial track period. For V-shaped servo grooves this means that the maximum groove width is substantially equal to the track period, so that the grooves would adjoin each other. From the point of view of manufacturing technology this is undesirable. However, it is also found that for deviations of the order of 25% from the ideal track width a very acceptable tracking signal can be obtained. Therefore, for practical versions of the record carrier body in accordance with the invention the optimum value for the maximum width of the servo-track portions is of the order of 75% of the radial track period. Deviations of the order of 20% from this optimum value are permissible.

Figure 6 shows a record carrier body in accordance with a preferred embodiment of the invention. In this embodiment the servo-track portions adjoin each other in a tangential direction and constitute a continuous spiral track or continuous concentric tracks 13. The sector addresses are now situated between the turns of the servo track 13. The optimum value for the maximum width of the servo track 13 is again of the order of 75% of the radial period P_r, and the maximum track width is again at least twice the maximum width of the sector-address areas.

Figure 7 is a radial sectional view of a part of this record-carrier body, taken on the line 7—7' in Figure 6 at the location where the sector addresses are situated. It is assumed that at the location where this sectional view is taken two areas 15 adjoin each other in a radial direction. After the description of the first embodiment with reference to the Figures 3 and 4, Figure 7 is self-explanatory. Figure 8 is a tangential sectional view of a part of the record-carrier body, taken on the line 8—8' in Figure 6. This Figure also requires no further explanation.

In the record-carrier body shown in Figure 6 the information areas 22 are recorded by the user in the lands between two servo-track portions 13 and between two sector addresses 12. Since the surface for recording the information areas is now entirely flat, these areas can be read even better by m ans of the integral method than in the case wh re the information areas are r corded in the wide servo track p rti ns of the record carrier body 1 shown in Figure 1.

Figure 9 shows the basic diagram of an apparatus by means of which th sector

addresses and the servo-track p rtions on a master disc can be produced. In this Figur th reference numeral 30 d notes the substrate of the master disc, for example a glass substrate. This substrate carries a photo-sensitive layer 31, whose thickness has been selected in such a way that the sector-address areas, formed after the development of the photo-sensitive layer, have a depth or height which is adapted to the wavelength of the beam with which the record-carrier body is to be scanned in order to obtain the correct phase depth. A radiation-source system 33 may comprise one laser or two separate lasers 34 and 35, for example argon-ion lasers. This system produces two radiation beams b_1 and b_2, of which b_1 serves for recording the sector addresses and b_2 for recording the servo-track portions. The narrow beams are widened, for example by means of telescopes comprising lenses 36, 37 and 39, 40 respectively, the beam b_1 being widened more than the beam b_2. Thus, the beam b_1 is given such a width that it fills a substantial part of the entrance pupil of the objective systems 45. After having traversed its telescope the beam b_2 is coupled into the path of the beam b_1 by the mirror 42 and a beam splitter, for example in the form of a beam-splitting mirror 43. A mirror 44 reflects the two beams to the objective system 45, which focuses each of the beams to form radiation spits V_1 and V_2, respectively. Since the beam b_1 fills a substantial part of the pupil of the objective system, this beam is focused to a minimal diffraction-limited radiation spot. The beam b_2, which fills a small part of the pupil, is focused to form a larger radiation spot V_2.

By rotating the disc about the axis 32 the radiation spots V_1 and V_2 will describe one turn on the disc. For recording a spiral track or a plurality of concentric tracks the radiation spots and the disc should be moved in a radial direction relative to each other either with a constant velocity or stepwise. For this purpose, the mirror 44 and the objective system 45 may be accommodated in a housing which is moved in the direction indicated by the arrow 46.

Modulators 47 and 49, for example acousto-optical modulators, are arranged in the radiation paths of the beam b_1 and the beam b_2, respectively, to switch the intensity of the relevant beam in conformity with the signal applied to the terminals 48, 48' and 50, 50', respectively. When the sector addresses are recorded the modulator 47 is switched between a high level and a zero level at a high frequency. In the present apparatus the modulator 49 is then set to the zero level. During the recording of the servo-track portions the modulator 47 is set to the zero level and the modulator 49 operates continuously at an intermediate level.

The exposure locally increases the solubility of th photo-sensitive layer. Th d sired reli f pattern is btained by a sel ctive rem val f th xp sed ph to-sensitive mat rial in a dev l p-m nt pr cess. The d pth and the width of the servo groov ar determined by the intensity of the beam b_2 and the width f the radiation spot V_2, respectively. After the master disc has been dev loped it may b coated with, for example, a silver layer. Subs qu ntly, this disc may b used in known manner for the manufacture of matrices, which are employed for the manufacture of a large number of replicas.

If the chief rays of the beams b_1 and b_2 are situated in the same X—Y plane, the radiation spots V_1 and V_2 are superimposed, as shown in the inset in the righthand part of Figure 9, assuming that the mirrors 42 and 43 are disposed at angles of 45° to said chief rays. Alternatively, the radiation spots may be shifted in the tangential direction of the disc, *i.e.* in the Y-direction in Figure 9, in such a way that the radiation spot V_1 is situated in front. For this purpose the radiation paths of the beams b_1 and b_2 should be shifted slightly relative to each other in the Y-direction.

For recording continuous servo tracks and sector addresses between the turns of the servo tracks it is in principle possible to use an arrangement similar to that shown in Figure 9, in which the modulator 49 is always at the intermediate level and the modulator 47 is switched between the high level and the zero level with a high frequency when the sector addresses are being recorded. The radial shift of the radiation spots V_1 and V_2 relative to each other can be obtained, for example, by positioning the mirror 42 at an angl which differs slightly from 45° relative to the chief ray of the beam b_2, as is shown in Figure 10. This Figure shows only that part of the radiation path where the beams are given different directions, *i.e.* the part beginning at the mirror 42.

Figures 9 and 10 show the basic diagram of the apparatus for recording the sector addresses and the servo-track portions, in which apparatus a number of variants are possible. For example, the radiation-source system may comprise only on laser followed by a beam splitter. In order to minimize the loss of intensity this beam splitter and the beam splitter 43 are preferably polarisation-dependent beam splitters and the singl radiation source, or the double radiation source 34, 35, should be capable of producing two beams which are polarised perpendicularly to each other. It is also possible to employ wavelength-selective beam splitters in conjunction with a single or double radiation source, emitting two different wavelengths. A shift of the radiation spots V_1 and V_2 in a radial direction, the X-direction in Figure 9, can also be obtained by an optical wedge in the path of the beam b_2, th mirror 42 extending parallel to the beam-splitting mirror 43.

The user of the record-carrier body should have a combined recording/read apparatus at his disposal for recording information and reading this information, and f r reading the sect r addresses both during recording and during information reading. Such combined apparatus ar known, for example fr m United States Patent Sp cificati n No. 4,363,116 and British Patent Specification No. 2,097,150. The kn wn apparatus are suitabl for

use in conjunction with a r cord-carrier body in which the s ctor addresses occupy the same radial positi ns as the ass ciated s rvo-track portions. For a r c rd-carri r body in which the servo-track portions constitute continuous tracks and the sector addresses are situated between the turns of the servo track, the tracking system in the known write/read apparatus may be modified in such a way that the scanning spot is held at a constant distance from the servo track in a way similar to that described in British Patent Specification 2,013,489 for a record carrier with deep and shallow tracks. Another possibility is to provide the write/read apparatus with means for the formation of an additional radiation spot for the purpose of tracking, in a way similar to that disclosed in British Patent Specification 2,016,747.

Figure 11 shows an example of such an apparatus. This Figure only shows the elements of the tracking system. The element 60 is a radiation source, for example a diode laser, which produces a beam b_3. The lenses 61 and 62 constitute a beam-widening telescope which ensures that the beam b_3 fills the pupil of the objective system 67 correctly. Instead of the telescope a lens may be used, which is arranged between the mirror 65 and the objective system 67. The beam reaches this objective system after reflections from the mirror 63, the beam-splitting mirror 64 and the mirror 65. The objective system focuses the beam b_3 to form a diffraction-limited radiation spot V_3 on the recording layer 18 of the record-carrier body *1*. This body can be rotated about an axis 68, and the mirror 65 and the objective system 67 can be moved together in a radial direction relative to the record-carrier body, the X-direction in Figure 11, as indicated by the mirror 75.

The mirror 63 and the beam-splitting mirror 65 serve to couple the auxiliary beam b_3 into the main radiation path of the apparatus, so that all the beams pass through the same objective system. The main radiation path is represented schematically by a broad beam $b_{0,1}$ ($b_{0,2}$) indicated by double arrows. The block 69 together with the mirror 66 and the objective system 67 constitute the known part of the apparatus. As is described in United States Patent Specification No. 4,363,116, it is possible to use only one radiation spot both for recording and reading. In that case the block 69 comprises one radiation source, for example a diode laser, a beam-widening and collimating lens system, a modulator, a radiation-sensitive detection system, and a beam splitter for diverting the radiation which has been reflected by the record carrier body to the detection system which supplies the address signals and the information signals.

Another version of the block 69 produces two radiation beams $b_{0,1}$ and $b_{0,2}$ which are focused by the objective system t form two radiation sp ts V_1 and V_2 which are shited relativ to ach ther in the tangential directi n of the record-carrier body, *i.e.* in the Y-direction in Figure 11. The radiation sp ts V_1, V_2 and V_3 have th same dimensi ns. In the present example the block 69 comprises, for example, two diode lasers, a beam splitter for recombining the two laser b ams after one of them has passed through a m dulator, a second beam splitter for diverting the beams reflected by the record-carrier body, a third beam splitter for separating the two beams, and a separate detection system for each of the beams. The beam $b_{0,1}$, which forms the radiation spot V_1, serves for reading the clock signals and the addresses and for recording the information, and the beam $b_{0,2}$, which forms the radiation spot V_2, is employed for reading the information. For further details about a block 69 which is capable of producing one or two radiation beams reference is made to the United States Patent Specification No. 4,363,116 and British Patent Specification No. 2,097,150, respectively.

The auxiliary beam b_3 is reflected by the record-carrier body and returns along itself until it reaches a beam splitter 70. This beam splitter reflects a part of the beam b_3 to a radiation-sensitive detection system comprising two detectors 71 and 72. The output signals of these detectors are applied to a differential amplifier 73. The output signal S_r of this amplifier contains information about the magnitude and the direction of a deviation between the centre of the radiation spot V_3 and the central axis of the servo track. This signal is employed for correcting the radial position of the radiation spot V_3 and those of the radiation spots V_1 and V_2, for example by pivoting the mirror 65 in the direction indicated by the arrow 66 by means of an actuator 74 to which the signal S_r is applied.

Claims

1. A record-carrier body in which a user can record information by means of optical radiation, which record-carrier body comprises a substrate and a recording layer on said substrate and which has been provided with a preformed and optically detectable relief structure of servo track portions and sector addresses in which address information about associated recordable portions of the record-carrier body is contained in the form of optically detectable areas which alternate with intermediate areas, which areas in the sector addresses have another phase depth than the servo-track portions, characterized in that the maximum width ($W_{max.1}$) of the servo-track portions (13) is at least 60% of the track period (P_r), transverse to the track direction, and is at least of the order of twice the maximum width ($W_{max.2}$) of the sector-address areas (15).

2. A record-carrier body, as claimed in claim 1, characterized in that the servo-track portions constitute continuous tracks and the sector addresses are situated betwe n servo tracks which are situated adjacent ach other in a dir cti n transverse t the track directi n.

3. An apparatus forming a structure according to the structur f servo-track portions and sector addresses of th record-carrier b dy as a claimed

in Claim 1 or 2, comprising a radiation source system for producing two radiation beams, a separate intensity modulat r for each of th beams, and an objective system for focusing the beams to form two radiation spots of different dimensions (V_1, V_2), characterized in that the smaller radiation spot is employed for recording the sector addresses and the larger radiation spot for recording the servo-track portions.

4. An apparatus as claimed in Claim 3, characterized in that the two radiation spots have the same position viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded.

5. An apparatus as claimed in Claim 3, characterized in that the two radiation spots are shifted relative to each other viewed in a direction transverse to the longitudinal direction of the servo-track portions to be recorded.

Patentansprüche

1. Aufzeichnungsträgerkörper, auf dem ein Benutzer mittels optischer Strahlung Information aufzeichnen kann, wobei dieser Körper ein Substrat und eine Aufzeichnungsschicht auf diesem Substrat enthält und mit einer vorgeformten und optisch detektierbaren Reliefstruktur von Servospurteilen und Sektoradressen versehen ist, in denen Adreßinformation über zugeordnete aufzeichenbare Teile des Aufzeichnungsträgerkörpers als optisch detektierbare Gebiete enthalten sind, die mit Zwischengebieten abwechseln, welche Sektorgebiete eine andere Phasentiefe als die Servospurteile haben, dadurch gekennzeichnet, daß die maximale Breite (W_{max1}) der Servospurteile (13) wenigstens 60% der Spurperiode (P_r) quer zur Spurrichtung und wenigstens in der Größenordnung des Zweifachen der maximalen Breite (W_{max2}) der Sektoradreßgebiete (15) beträgt.

2. Aufzeichnungsträgerkörper nach Anspruch 1, dadurch gekennzeichnet, daß die Servospurteile ununterbrochene Spuren bilden und die Sektoradressen sich zwischen Servospuren befinden, die in einer Richtung quer zur Spurrichtung nebeneinander liegen.

3. Gerät zur Bildung einer Struktur entsprechend der Struktur von Servospurteilen und Sektoradressen des Aufzeichnungsträgerkörpers nach Anspruch 1 oder 2, mit einem Strahlungsquellensystem zum Erzeugen von zwei Strahlungsbündeln, mit einem abgesonderten Intensitätsmodulator für jedes der Bündel und mit einem Objektivsystem zum Fokussieren der Bündel zur Bildung von zwei Strahlungsflecken verschiedener Größe (V_1, V_2), dadurch gekennzeichnet, daß der kleinere Strahlungsfleck zum Aufzeichnen der Sektoradressen und der größere Strahlungsfleck zum Aufzeichnen der Servospurt ile ausgenutzt werden.

4. Gerät nach Anspruch 3, dadurch gekennz ichnet, daß, in ein r Richtung quer zur Längsrichtung der aufzuzeichn nd n Servospurteile gesehen, die beiden Strahlungsflecke die gleiche Stelle einnehmen.

5. Gerät nach Anspruch 3, dadurch gekennzeichnet, daß in einer Richtung quer zur Längsrichtung der aufzuzeichnenden Servospurteile gesehen, die beiden Strahlungsflecke gegeneinander verschoben sind.

Revendications

1. Corps de support d'enregistrement dans lequel l'utilisateur peut enregistrer de l'information à l'aide de rayonnement optique, lequel corps de support d'enregistrement comporte un substrat sur lequel est appliquée une couch d'enregistrement et qui est munie d'une structure en relief préformée, optiquement détectable, ayant des parties de servopiste et des adresses de secteur dans lesquelles est contenue de l'information d'adresse concernant les parties enregistrables correspondantes du corps de support d'enregistrement sous forme de domaines optiquement détectables qui alternent avec des domaines intermédiaires, lesquels domaines dans les adresses de secteur présentent une autre profondeur de phase que les parties de servopist , caractérisé en ce que la largeur maximale ($W_{max.1}$) des parties de servopiste (13) est d'au moins 60% de la période de piste (P_2), transversale à la direction de la piste, et est d'au moins de l'ordr de deux fois la largeur maximale ($W_{max.2}$) des domaines d'adresse de secteur (15).

2. Corps de support d'enregistrement selon la revendication 1, caractérisé en ce que les parti s de servopiste constituent des pistes continues et les adresses de secteur sont situées entre des servopistes situées de façon adjacente dans un direction transversale à la direction de la piste.

3. Appareil formateur d'une structure selon la structure des parties de servopiste et d'adress s de secteur du corps de support d'enregistrement selon la revendication 1 ou 2, comportant un système de source de rayonnement pour réaliser deux faisceaux de rayonnement, un modulateur d'intensité séparé pour chacun des faisceaux et un système d'objectif pour focaliser les faisceaux afin de former deux spots de rayonnement d différentes dimensions (V_1 et V_2), caractérisé en ce que le plus petit spot de rayonnement est utilisé pour l'enregistrement des adresses de secteur et le plus grand spot de rayonnement pour l'enregistrement des parties de servopiste.

4. Appareil selon la revendication 3, caractérisé en ce que les deux spots de rayonnement présentent la même position, vu dans une direction transversale à la direction longitudinale des parties de servopiste à enregistrer.

5. Appareil selon la revendication 3, caractérisé en ce que les deux spots de ray nnement sont décalés l'un par rapport à l'autre vu dans une direction transv rsale à la directi n l ngitudinale des parties de serv piste à nr gistrer.

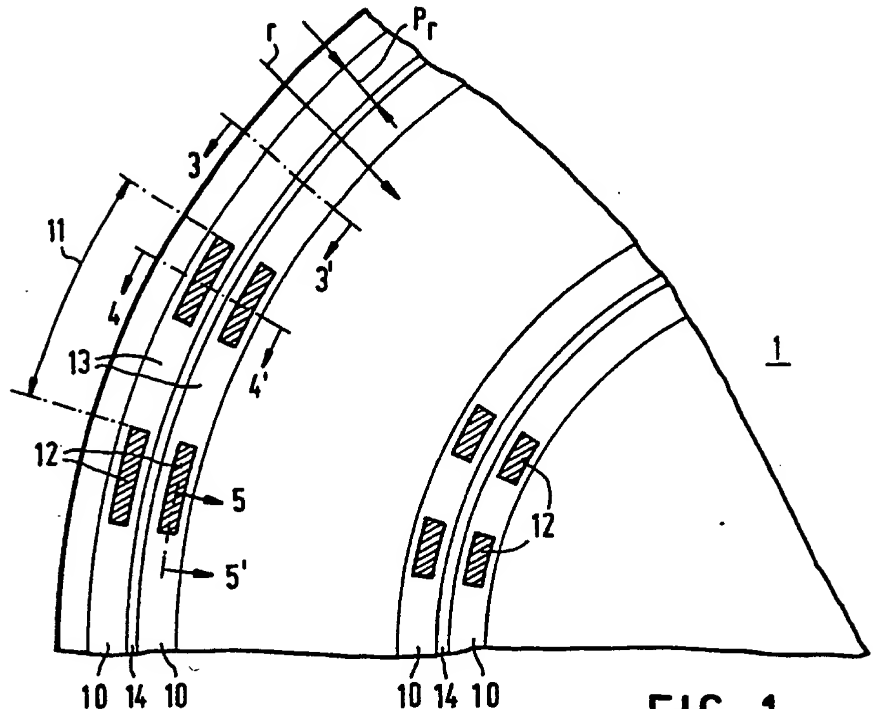

FIG. 1

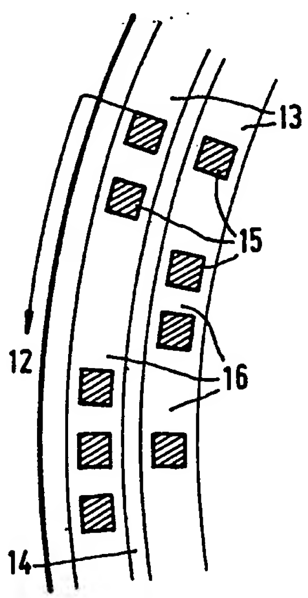

FIG.2

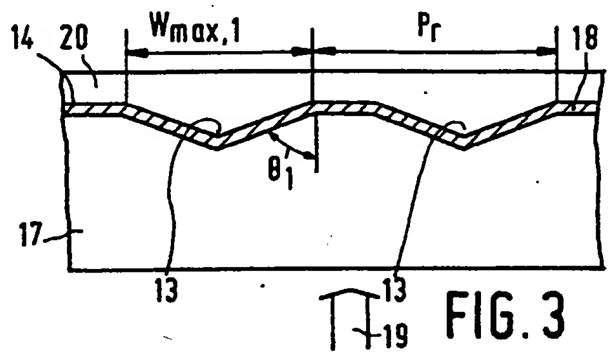

FIG.3

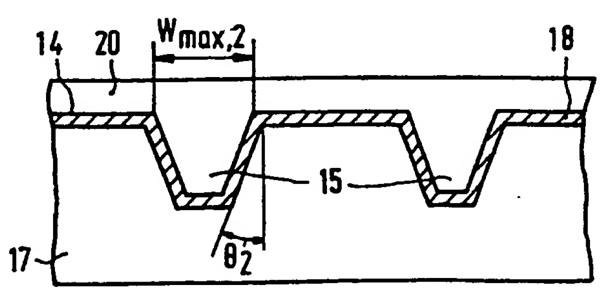

FIG.4

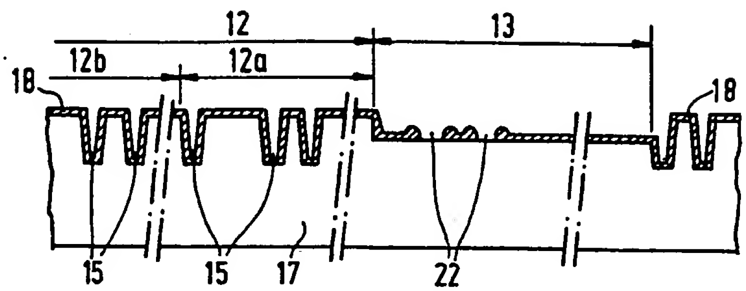

FIG.5

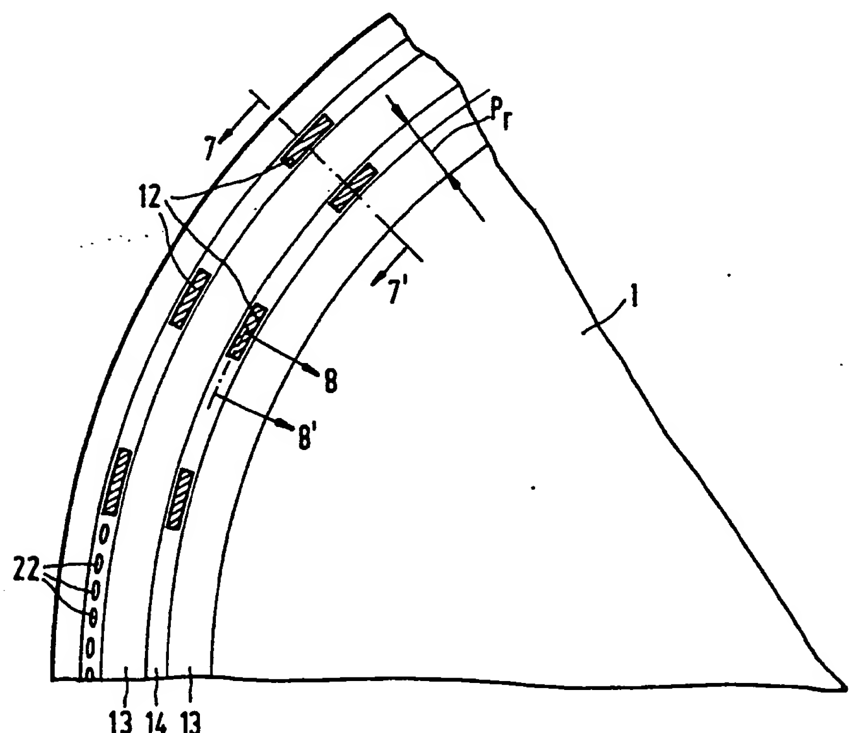

FIG.6

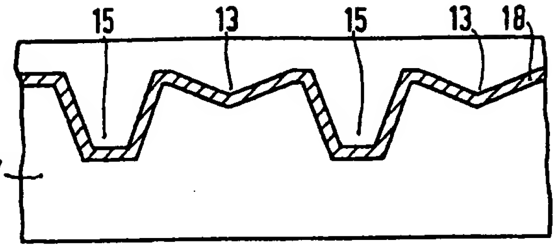

FIG. 7

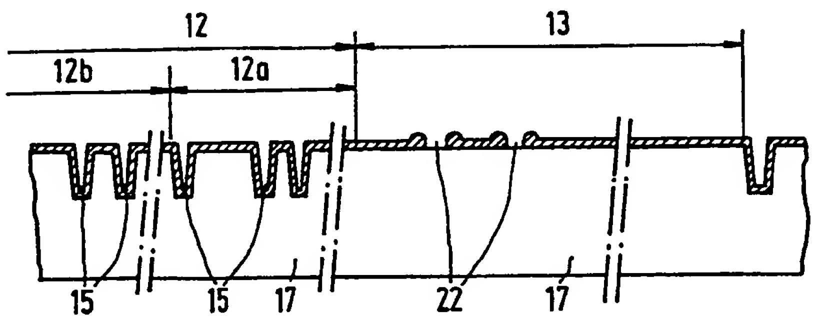

FIG. 8

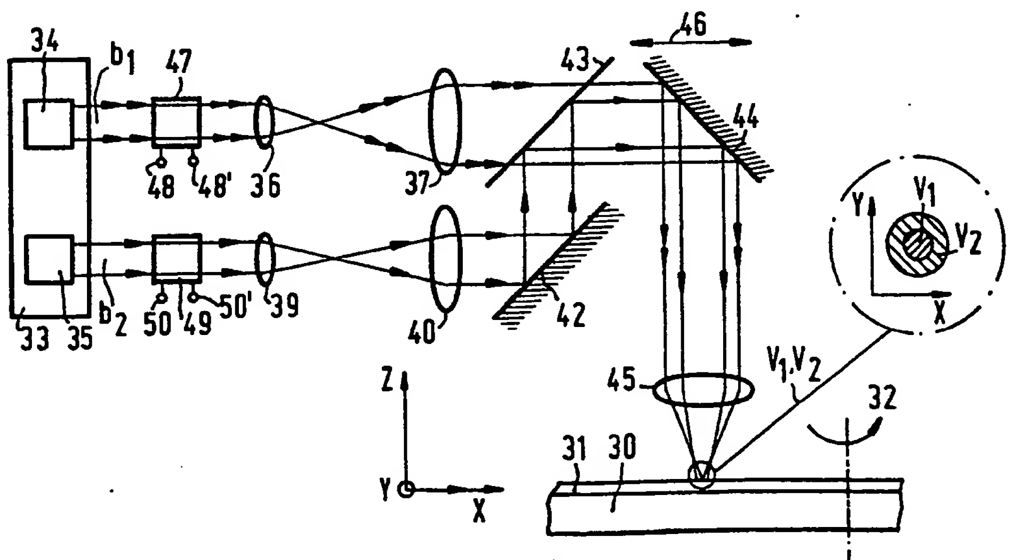

FIG. 9

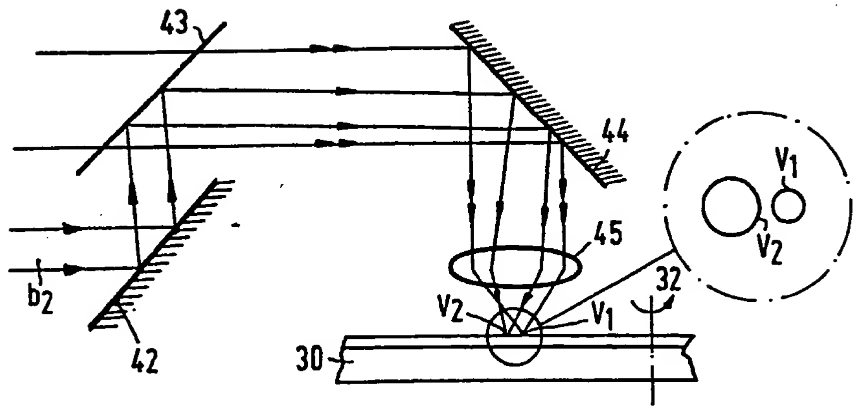
43
44
45
32
V1
V2
b2
42
30

FIG.10

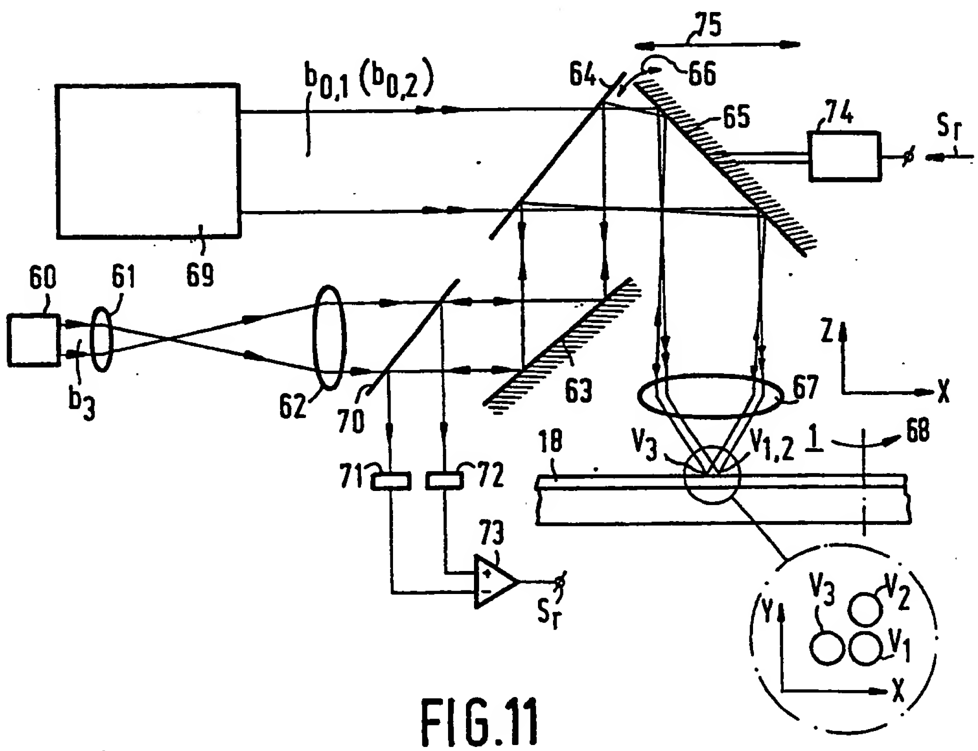
75
64
66
65
74
Sr
69
60
61
62
63
70
67
Z
X
18
V3
V1,2
1
68
71
72
73
Y
V2
V1

FIG.11